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curator department of birds in the Smithsonian institution. The work is to contain some 435 illustrations suitably executed, and will conform to the geographical limits, classifications, numeration, and nomenclature adopted by the American ornithological union. We doubt not it will be a most important contribution to the literature of the subject, and presume that naturalist and sportsman alike will find in it an aid.

— Mr. N. S. Goss's revised list of the 'Birds of Kansas' gives notes on three hundred and thirty-five species occurring in that state, one hundred and seventy-five of which are known to breed within its limits. This little work contains the results of a large amount of labor, and is highly creditable to its author.

— 'The young collector' (London, *Sonnenschein & Co.*) is the title of a very cheap and convenient series of small handbooks designed for the amateur, tastefully and neatly gotten up, and issued at one shilling each. Four of them, so far, have appeared, on 'Mosses,' by J. E. Bagnall; on 'British butterflies, moths, and beetles,' by V. F. Kirby; on 'Seaweeds, shells, and fossils,' by Peter Gray and B. B. Woodward; and on 'English coins and tokens,' by L. Jewitt and B. V. Head. These little handy handbooks contain simple directions for the collection and preservation of specimens, with a general introduction to scientific classification, habits, etc., interpersed with numerous engravings. To the boy or girl with an awakening propensity to collect (and every healthy boy at some period of his career has a more or less enduring hobby of some sort or other). these little works will serve as useful guides even in America. Why cannot some publisher get out similar and as cheap handbooks, more expressly serviceable for the young American collector?

— The longest clock pendulum known is said to be one in Avignon, France, measuring sixty-seven feet, to which is attached a weight of one hundred and thirty-two pounds. Its movement is slow, passing through an arc of between nine and ten feet in four seconds and a half.

— Mr. J. H. Long, in a recent paper on the microscopic examination of butter, arrives at the conclusions, that. "taking all things into consideration, we have no absolutely certain method of distinguishing between butter and some of its substitutes, and that, of all methods proposed, the microscopic are perhaps the least reliable." These conclusions are similar to the ones reached by Prof. H. A. Webster, but are directly opposed to those of Dr. Taylor.

— The mortality of horses in New York City during 1885 reached nearly seven thousand; and during the past six years nearly forty thousand dead horses were received at the receiving-docks.

— Recent researches by Messrs. Coleman and McKendrick of England, on the effects of extreme cold on certain microbes, especially those concerned in putrefactive changes, show that the organisms are killed by exposure to a temperature of from 80° to 120° F. below zero, though their germs are unaffected, and speedily develop after an increase of temperature.

— We learn from the *Athenaeum* that the necessary funds have been granted for the expenses of the British expedition to observe the total eclipse of the sun on Aug. 29. The party, which will probably include Mr. Maunder and Mr. Turner of the Greenwich observatory, will occupy three stations on the island of Grenada in the West Indies. Totality occurs there about quarter-past seven o'clock in the morning, and lasts very nearly four minutes. A proposal was made some time ago to despatch a German party to Benguela on the west coast of Africa, the most favorable point from which observations could be made; but we have not heard that it has assumed a tangible form. The bill introduced in congress for fitting out an American expedition seems to have been buried with some committee, and it is now, of course, too late for proper preparation, even if the bill could be pushed through.

— The president of the province of the Amazonas, Brazil, has authorized the employment of Francisco Pfaff, of Geneva, Switzerland, as the chemist of the botanical gardens established at Manaus a few years ago. It will be the duty of the chemist to study and report upon the medicinal and industrial properties of the plants of the Amazon valley.

LETTERS TO THE EDITOR.

⁂ Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.

Sea-level and ocean-currents.

THE subject of sea-level and ocean-currents is not so simple that there is not room for differences of opinion. It is not to be denied that exceptionally strong winds, such as Texas northers or those of violent cyclones, often cause considerable changes of sea level in shallow water like that of Lake Erie, or of the thin stratum of the same depth, and much less near the shore, along the Atlantic coast and the border of the Gulf of Mexico, extending mostly to a distance many miles from the coast, where the bottom of the shallow water drops off abruptly into deep sea-water. But the effects of winds of the same strength upon deep sea-water are comparatively very small.

If we suppose Lake Erie to be two hundred miles in length and two hundred feet in depth, and a wind

with a velocity of forty miles per hour to blow over it from one end to the other, we have, no doubt, approximately the conditions under which Dr. Newberry made his observations. Such a wind, then, causes a surface gradient in Lake Erie of four feet in two hundred miles. The first effect of the wind is to drive the surface water from one end of the lake toward the other, and thus to cause a gradually increasing surface gradient. The difference of pressure arising from this gradient causes a counter-current in the lower strata of the lake, and the static condition with regard to change of gradient takes place when the force arising from this gradient is sufficient to overcome the friction, and maintain a counter-current sufficient to return the water below just as fast as it is driven forward above by the wind. This is required to satisfy the condition of continuity, — a condition which, in all such cases, must be satisfied after the maximum gradient has been reached, and there is no further accumulation of water at the one end or a diminution at the other.

The force of the wind is applied directly to the surface only, but is communicated to the strata below by means of the friction between the successive strata of gradually decreasing velocities with increase of depth in the upper strata, and gradually increasing velocities in the contrary direction at depths below the neutral plane which separates the direct from the counter currents. If we assume, as usual, that friction is proportional to the relative velocities between the strata, then, in order to distribute equally the force at the surface to the strata below, it is necessary for these relative velocities to decrease in proportion to increase of depth, and finally vanish; and consequently the absolute velocity must be comparatively very great at the surface, and diminish, rapidly at first and then gradually less, until the neutral plane is reached, when this velocity vanishes, and changes sign at lower depths. Since the direct velocities in the upper strata are very great in comparison with those of the retrograde motion below, it is evident that the neutral plane cannot be at any great depth in comparison with the whole; since where the velocities are least the transverse sectional areas must be greatest, in order that there may be as much flow in the one direction as the other.

Upon the hypothesis of no frictional resistance from the bottom to the counter-flow below, the relative velocities between the strata would vanish, and the maximum velocity of the counter-current would take place, at the bottom. In this case the force by which the water, held at a certain gradient by the force of the wind, tends to be restored to its level, is an exact measure of the force of the wind. This force, it is well known, is measured by the product of the mass into the acceleration of gravity along the descending gradient. But the mass for the same lake being proportional to the depth, and the acceleration proportional to the gradient, a relative measure of the force of the wind is the surface gradient multiplied into the depth. For the same wind, therefore, the gradient is inversely as the depth.

In the case of frictional resistance to the counter-current at the bottom, as there always is, of course, the maximum velocity of the counter-flow, and the vanishing of the relative velocities, take place at a plane a little above the bottom; and in this case the static gradient must be such that the force arising from it must not only be sufficient to overcome the force of the wind, as communicated by friction to the several strata down to the plane of the greatest velocity of counter-flow, but likewise to overcome the friction of the bottom, communicated in like manner upward to the strata above, as far as to the plane of greatest velocity of counter-flow, where the relative velocities vanish, and where, consequently, the effect of friction from the bottom must stop. But this is small in comparison with the whole force, and for different depths is proportional to the gradient. We therefore still have, for a relative measure of the force of the same wind, in the case of varying depths, the product of the gradient into the depth, and consequently the gradient inversely as the depth.

If, then, we suppose the depth of Lake Erie to be increased 60 times, or to the depth of 12,000 feet, a wind with a velocity of 40 miles per hour would cause a gradient of only the one-sixtieth part of the observed gradient, or 0.8 of an inch, in 200 miles; but, on the other hand, if the depth were less, the gradient would be proportionately increased. Hence it is seen how greatly the gradient, and consequently the change of sea-level, belonging to a given wind, depends upon depth. But the difference of sea-level, of course, other conditions being the same, is proportional to the length. Hence, if we increase the length of the lake 15 times, or to a length of 3,000 miles, the difference of level then would be 15 times 0.8 of an inch, or one foot With the depth increased 60 times and the length 15 times, we have approximately the conditions of a section of the Atlantic Ocean extending from New York harbor to the coast of France; and a westerly wind, therefore, of a velocity of 40 miles per hour, would cause the sea-level to be one foot higher at the latter place than at the former. But the average wind blowing across the Atlantic we know is very much less than this, and therefore its effect cannot be nearly so great as this.

The mean annual velocity of the wind across the Atlantic in middle latitudes is approximately known from the mean barometric gradient. The difference between the annual mean of the barometer at Iceland and the parallel of 35° is about 10 millimetres; and this gives a gradient on the parallel of 45° which corresponds to a westerly wind of about 8 miles per hour. The relation between wind friction upon water and the velocity of the wind is somewhat uncertain; but it increases at least at as great a rate as the first power of the velocity, and probably at a rate considerably greater. But, assuming it to be as the velocity, then the average westerly wind between America and France causes a difference of sea-level between the two of only 2.4 inches. If wind-friction were as the square of the velocity, it would be only a half-inch. It undoubtedly falls somewhere between these two values, but even by the former the effect of the average wind in causing a difference of sea-level is very small.

But there is another argument, entirely independent of the observations on Lake Erie, or any absolute wind velocities, from which we deduce about the same conclusions. It is well known from barometric monthly averages that the barometric gradient between Iceland and the parallel of 35° is at least twice as great, on the average, in January as in July. Whatever the absolute velocities of the wind corresponding to given gradients may be, we know that they are proportional to the gradients, and conse-

quently the westerly winds must be at least twice as strong in January as in July, notwithstanding Dr. Newberry seems to think there may not be much difference. If the annual average velocity of wind, therefore, whatever it may be, causes a difference of level between America and France of 2.4 inches, then this difference in January is 3.2 inches, and in July only 1.6 inches, and consequently a change of difference of sea-level of 1.6 inches between the two seasons. The discussion of long series of tide observations on both sides of the Atlantic gives a small annual inequality of sea-level with a range of several inches; but both the ranges and the epochs of maximum height of sea-level are nearly the same on both sides, the latter occurring in the fall; and so there can be, at most, only a very small change between January and July, not possibly as much as 1.6 inches, and therefore the average wind of the year cannot cause a difference as great as 2.4 inches, deduced from the preceding argument upon the hypothesis that wind-friction is in proportion to the velocity. It is admitted that some of the data upon which these results are based are somewhat uncertain; but if some of them are in error, a fourth or even a third part, it affects the argument very little.

Upon the usual assumption that friction between the different strata of water is proportional to the relative velocities without regard to difference of pressure at different depths, it is readily inferred, from what precedes, that the absolute surface velocity is independent of depth of water, and so a westerly wind of 40 miles an hour across the Atlantic would give rise to the same surface velocity as on Lake Erie. Dr. Newberry has not furnished us with any observation of surface velocity, and therefore we cannot infer what the velocity of surface water on the Atlantic, corresponding, say, to the average velocity of about 8 miles per hour, would be. This, if wind-friction is proportional to the velocity, would be one-fifth of that on Lake Erie corresponding to a velocity of 40 miles per hour. If the wind does not blow the water against a barrier, but in circuits, of course the case is very different.

In the trade-wind latitudes the westerly component of motion is perhaps about the same as the easterly component of the middle latitudes in the North Atlantic; and, as the tropical sea between Africa and the Gulf of Mexico is much deeper, we may infer, from what precedes, that the trade-winds cannot possibly cause a difference of sea-level of two inches, and hence raise the level of the Gulf of Mexico as much as one inch above the normal undisturbed level. The winds, therefore, can have no sensible influence in producing the Gulf Stream, for this deep and rapid current can only be caused by a difference of sea-level between the Gulf and the parts in higher latitudes toward which it flows.

WM. FERREL.

Washington, July 18.

Neff's gas-wells.

In the geological map of Ohio, showing the positions of the oil and gas wells (*Science*, June 25, 1886), there is a circle enclosing these words, 'Neff's gas-wells.' This region was discovered in 1864 as geologically, and in many particulars physically, the duplicate of the Venango county, Penn., region. In 1865 well No. 1 was bored, proving the substratification of the subcarboniferous shales and sands to be the equivalents of those in Pennsylvania; but, in place of striking oil, there was developed a remarkable gas-well, which has been described by tourists and scientific men as a geyser of great violence. A full account of all the wells has been published in the Ohio state geological survey, and quite recently in the tenth volume of the Tenth census of the United States, by Prof. S. F. Peckham.

Some of the wells discharge a few gallons of oil each day, of a superior lubricating quality, gravity 32°.

The analysis of the gas is as follows: —

Marsh-gas	81.4
Ethyl hydride	12.2
Nitrogen	4.8
Oxygen	0.8
Carbon monoxide	0.5
Carbon dioxide	0.3
	100.0

There is also a small amount of free hydrogen which is carburetted before burning.

The analysis of the carbon, known as an article of commerce by the trade-mark, 'Patented diamond black,' produced from the gas of these wells by patented processes granted the writer, is as follows: —

Carbon [1]	95.057
Hydrogen [1]	0.665
Nitrogen	0.776
Carbon monoxide [2]	1.378
Carbon dioxide [2]	1.386
Water	0.682
Ash (Fe_2O_3 and CuO)	0.056
	100.000

The pressure on these wells is not the same in all. There is a pressure for each well; at which degree of pressure there is an equilibrium between the generation or discharge of the gas, and the well's state of rest or quiet. Very little salt water is found in these wells, and it gives little trouble. Observations show that the supply increases in warm weather and in the heat of the day, and regularly with the variations of the moon, being strongest at the full moon. The gas is a rich illuminating hydro-carbonaceous gas, and, even when mixed with seven parts of atmospheric air, is a good illuminant. Well No. 2 has been systematically examined; and there is no apparent diminution in the supply of gas, during the past fourteen years of the twenty years the well has been 'blowing.' Where is it from?

That there is a limit to the supply of petroleum or gas cannot be questioned; but, with proper scientific and economical use of wells and territory, the life of a well can scarcely be measured or computed: it is too great in quantity, and too long in time.

Fresh water will 'drown out' a well. Will not holding a well under pressure until its equilibrium between a state of rest and production is about established, injure the well? It is an injury; therefore transporting gas through long lines of pipe, by an initial potential force amounting to several hundred pounds' pressure at the wells, is not the correct way. There is a reduction of pressure of about eight pounds to the mile in pipes. For long distances it will be proven that gas can be blown more economically, and to better advantage to wells and transportation, through the pipes, than be forced by its

[1] Including the C and H of 0.024 solid hydrocarbon.

[2] These gases were doubtless partly formed from solid carbon and occluded oxygen by the heat applied *in vacuo*.